

## Features

- Compact, simple, rugged and economic design
- Simple wiring and DIN rail mounting
- Interface for one or two 1S30 arc fault sensors
- High speed arc fault tripping output to interface with protection relay status inputs
- Apply to initiate IEC61850 GOOSE messaging of arc fault events
- Continuous arc fault sensor supervision
- Arc fault pick up and supervision healthy indication
- 24, 32, 48, 110 and 125V DC auxiliary versions

## Introduction

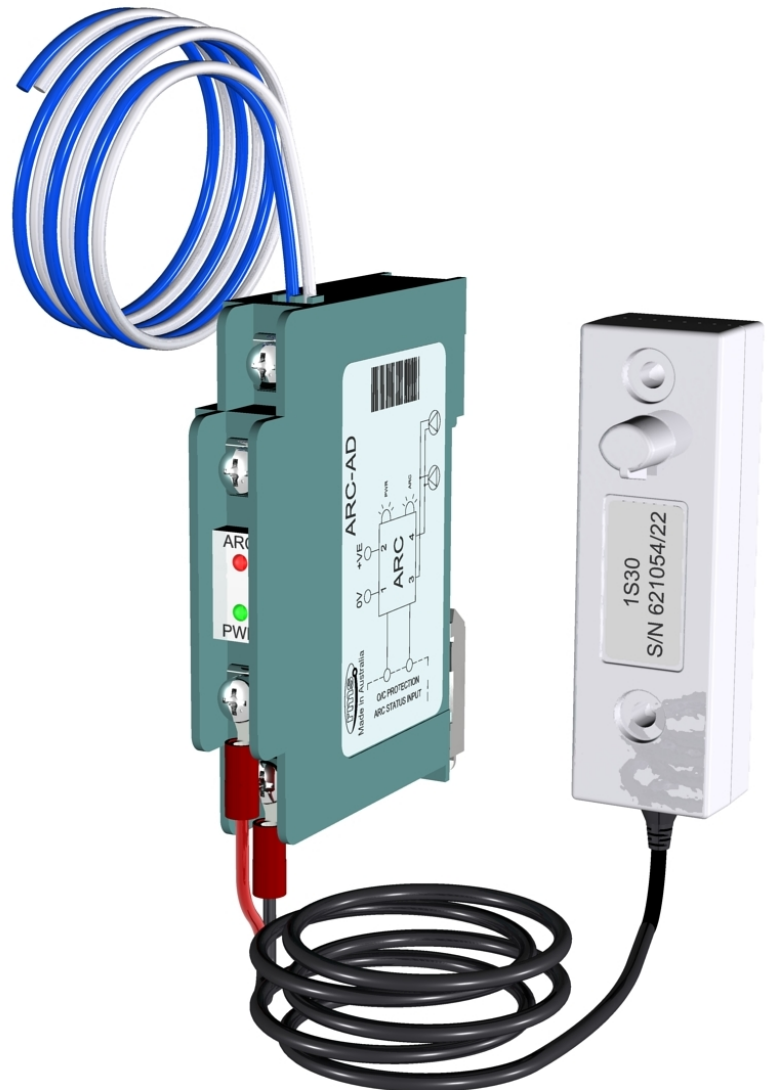
Medium voltage switchgear is a key element in the power supply chain. Existing protection systems operate effectively under most circumstances, but they are too slow to handle arcing short circuits.

Arcing faults can occur as a result of insulation breakdown due to equipment age and / or poor maintenance.

The degree of damage caused by arcing depends principally on the duration of the arc. If an arc lasts only 100ms, the switchgear needs to be checked and the insulation resistance measured before power can be re-established. With a 200ms arc, the power supply will be interrupted; the switchgear must be checked; power is re-established only after minor repairs. In the event of a 500ms arc the supply is interrupted, metal parts of the switchgear are destroyed and poisonous gases are emitted. A 1s arc destroys most of the switchgear and may cause a fire, injury to personnel and damage to property.

The over-current caused by an arc is, due to its resistance, lower than the over-current caused by a "metallic" short circuit. For moderate arc fault currents the trip time of the over-current IDMT stage will be too slow.

The consequence of these conditions is that a protection system based solely on over-current detection cannot effectively protect the switchgear against an internal arcing fault.



ARC Fault Interface Module and 1S30 optical arc sensor  
Blue and white flying leads interface to protection relay status inputs

## ARC Fault Protection

Made in Australia

Arc fault protection is a relatively new technique employed for the fast clearance of arcing faults on BUS bars and within metal clad switchgear and associated cable boxes. The arc is detected using an optical sensor and the signal input to a protection device which also monitors the load current on the system. A trip signal can be achieved in less than 1ms using arc detection only or within 15ms when using overcurrent check. This is considerably faster than a traditional IDMT overcurrent relay and provides additional protection from the onset of arcing faults with relatively low fault currents.

Arguably the greatest risk of arc fault damage exists at the CB cable termination and in the CB chamber itself due to the slow clearance times of the IDMT feeder protection. The CB cable termination is particularly at risk to ingress of moisture and rodent damage.

The problem of arc faults is most prevalent in older metal clad switchgear which already has operational protection systems. The ARC Fault Interface Module has been designed for the following applications:

### ARC FAULT INTERFACE MODULE

The Arc Fault Interface Module (ARC Module), described in this document is designed to connect one or two optical arc fault sensors to a protection relay status input.

Refer to the 1S30 Technical Bulletin for details on the arc fault sensor.

**SWITCHGEAR ARC PROTECTION**

Risk of arc fault damage exists at the CB cable termination and in the CB chamber itself. The CB cable termination is particularly at risk to ingress of moisture and rodent damage.

1S30 Arc Sensors may be located as depicted in the single line application diagrams at right.

Modern numeric feeder protection relays provide internal logic functions that may be programmed to interface with the ARC Module. Refer to figure 9 for details.

Depending on the model of protection relay being used this input may be programmed to provide not only a high speed arc fault trip output but also an alarm message on the HMI and time stamped event record via its communications link.

This level of system integration allows the ARC Module to be back of panel mounted with the alarm indications programmed to be displayed on the protection relay front panel.

**CABLE BOX PROTECTION**

Figure 1 shows the trip signal being used to trip the feeder circuit breaker in the event of an arc fault occurring in the cable box provided the overcurrent relay starter logic is picked up.

**CT CHAMBER PROTECTION**

In circuit breakers where the CT is screened from the cable box a second sensor and ARC Module may be deployed as per figure 1.

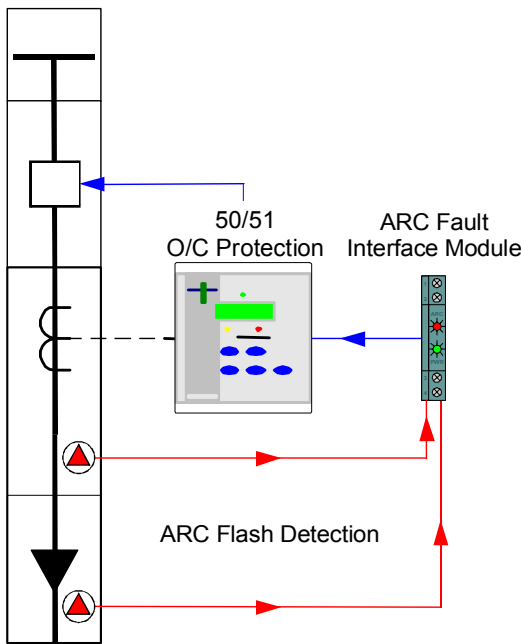


Figure 1: Cable box and CT chamber protection

**Switchgear Applications**

**CIRCUIT BREAKER CHAMBER PROTECTION**

Arc fault occurring within the CB chamber must be cleared by the upstream breaker. This may be achieved as depicted in figure 2. Note the optional use of GOOSE messaging over IEC61850 to communicate an arc fault condition to the incoming feeder protection relays. Programmable logic may then be applied in these relays to open the appropriate up-stream circuit breakers to clear the fault.

Where trip signaling is achieved using conventional wiring, the trip output connection should be terminated in close proximity to the ARC Module and screened cable employed to transfer the trip signal to the up-stream protection relay status input.

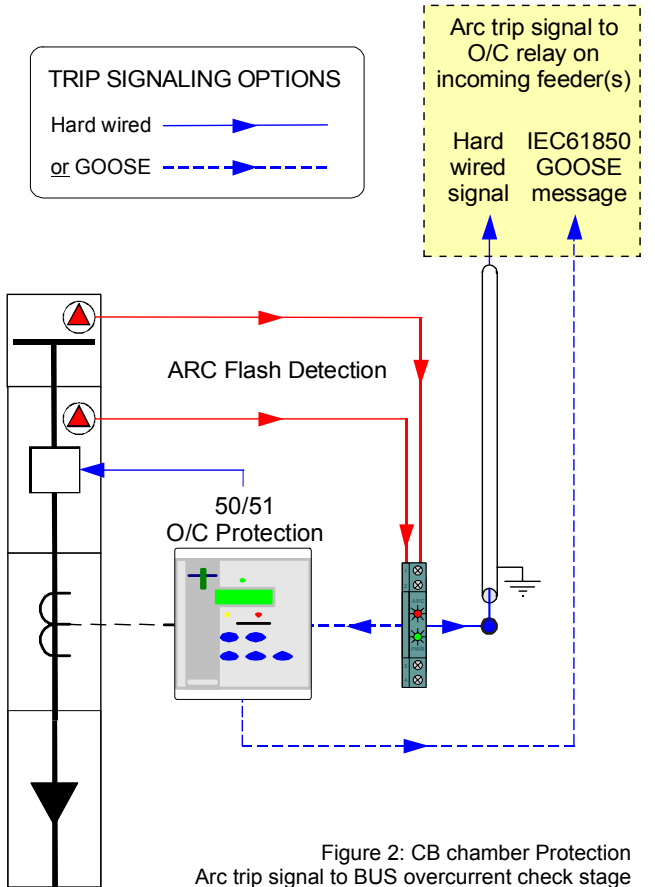


Figure 2: CB chamber Protection Arc trip signal to BUS overcurrent check stage

**MULTIPLE ARC FAULT INTERFACE MODULES**

Figure 3 depicts multiple Arc Fault Modules connected to a single status input. This scheme may be employed where more than one sensor is required to protect a single arc protection zone.

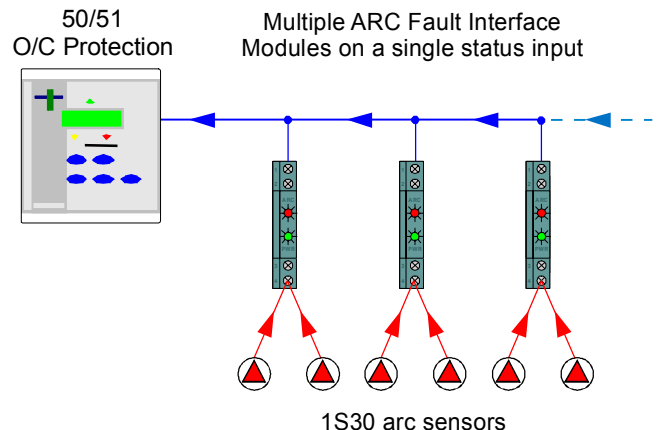


Figure 3: Multiple ARC Modules per status input

### FRONT PANEL LAYOUT

Two LED's are integrated into the front panel to provide the following status indications:

#### GREEN Auxiliary supply indication

A green LED is continuously illuminated to indicate presence of the auxiliary supply and normal operation including supervision of the 1S30 sensor(s).

#### RED Arc fault pick-up

A red LED is illuminated when an optical signal above the detection threshold is present. This LED will self reset when the optical signal falls below the detection threshold with a minimum dwell time of ~2s.

This feature is useful during commissioning and routine tests to verify correct operation of the system.

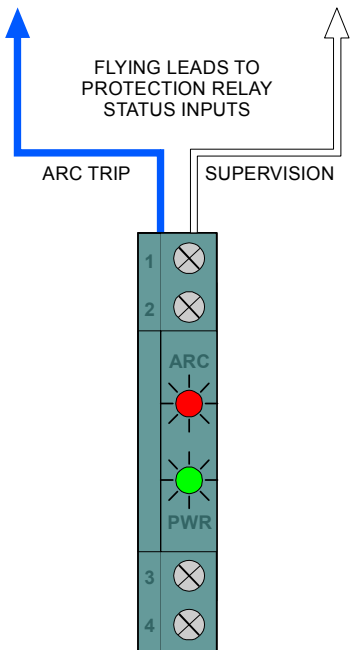


Figure 4: ARC Fault Interface Module front panel layout

### ARC SENSOR CONTINUOUSLY PICKED UP

High ambient light levels may cause a 1S30 to be continuously picked up. This condition could occur for example if the CB cable box cover was left open in very high ambient light level conditions. A non arc fault over-current pick up would then result in an arc fault trip operation.

To avoid possible mal operation due to this condition, the ARC module is designed to automatically disable the arc fault tripping function if the 1S30 sensor is picked up for >500ms. The ARC Module will then disable the healthy supervision signal and the front power LED will flash until the ambient light level problem is corrected. The ARC Module will then perform an arc sensor test function and automatically reset.

### ARC DETECTION RESET TIME (Effect of multiple arc trips)

A delay of >500ms is required to reset the ARC Module after an initial arc sensor trip. Subsequent arc detection will cause the trip contact to re-operate.

## Operation

### ARC SENSOR FUNCTION

The 1S30 is an optical sensor that responds to the flash of light emitted during the incidence of an arcing fault. Onset of the light flash and detection by the 1S30 occurs in a few ms.

When an arc is detected, the resistance presented by the 1S30 drops to a level where the current flow increases to approximately 20mA. This increased current flow is detected by the ARC Module which responds in <1ms to close a solid state contact to activate the arc fault input on the protection relay as depicted in figures 6 and 7.

### ARC SENSOR SUPERVISION

The 1S30 Arc Sensor is the heart of the system and supervision of the circuit continuity is critical for correct operation. To monitor the integrity of the wiring between the 1S30 arc sensor and the ARC Module, a continuous 2mA supervision current flows between the units. A supervision healthy signal is output to the protection relay status input. This signal will be disabled after an ~1s time delay if the supervision current signal is lost.

Where a fault is detected on the Arc Sensor circuit the front panel power LED will slowly flash.

### ARC FAULT TRIPPING USING CURRENT CHECK

Fast operation of a tripping scheme usually results in reduced system security. The arc detection method can however, combine the optical detection technique with a traditional overcurrent method to maximize system security. Both conditions must coexist for the trip condition to be met as depicted in figure 6 and 7.

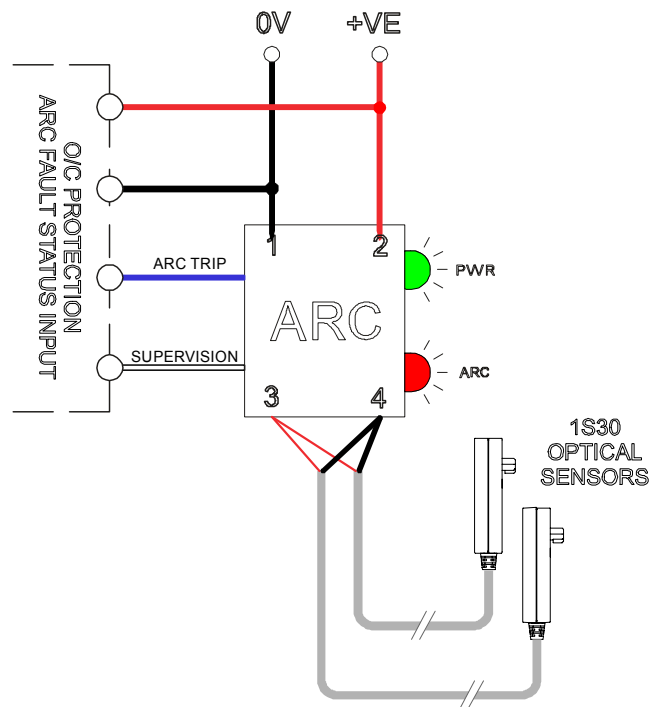


Figure 5: Key components required to implement an Arc Fault Protection scheme with an overcurrent check stage to enhance system security

The application examples in figures 1 and 2 utilize this concept for enhanced system security in that both the ARC Module AND the OC 50 starter logic must be picked up for a CB trip signal to be initiated. As the arc fault trip contact picks up considerably faster than the overcurrent relay starter element, the CB trip time will be dictated by the overcurrent relay performance.

# Relay Logic & Wiring

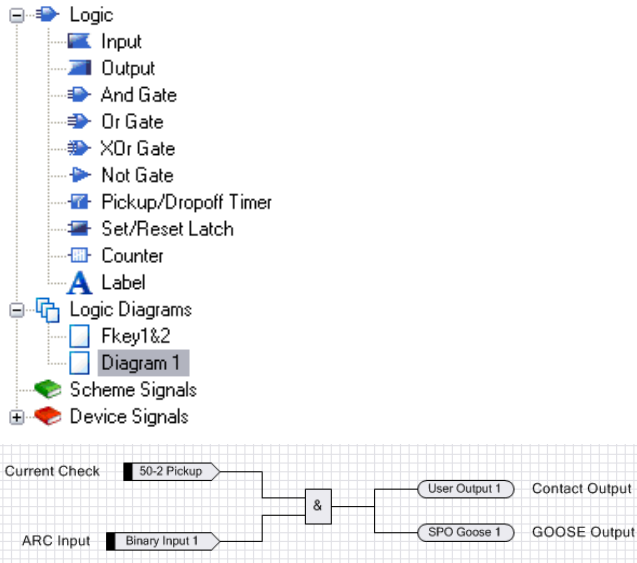


Figure 6: Reyspl Manager logic programming

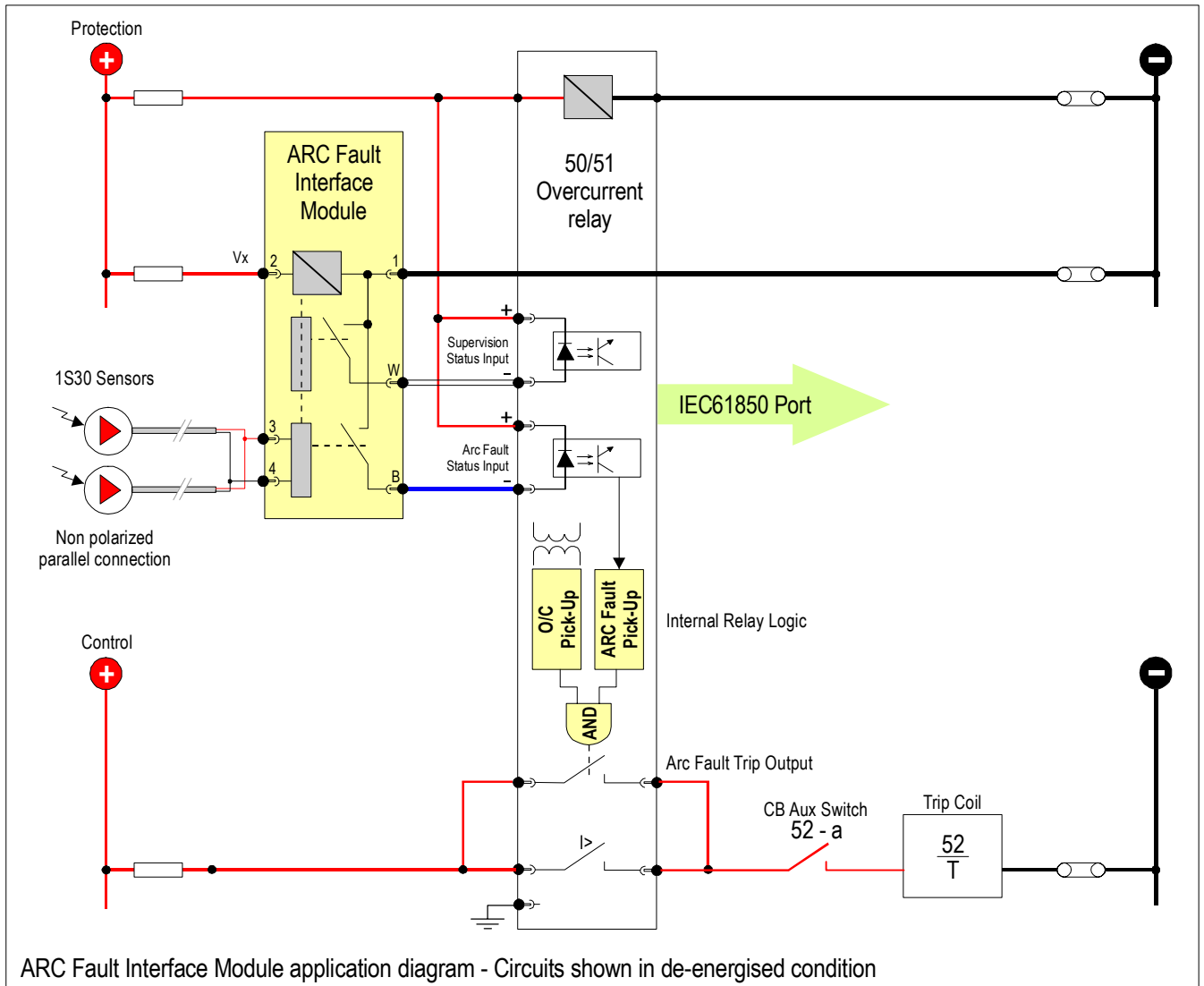
## PROTECTION RELAY LOGIC

For the current check scheme to function correctly a protection relay with the following attributes is required:

Attribute	Parameter	Necessity
Programmable relay logic	AND gates	Mandatory
High speed status input	<5ms pick up	Mandatory
High speed current check element – 50FA	<15ms at 2x setting	Mandatory
Programmable front panel indication	Arc trip indication	Desirable
	Supervision status	Desirable
IEC61850 for trip signaling	GOOSE messaging	Optional

A suitable relay available with all of the above attributes is the Reyrolle 7SR21/22 platform multi-function feeder manager.

A screen shot of the Reyspl Manager logic programming software is shown in figure 6.



ARC Fault Interface Module application diagram - Circuits shown in de-energised condition

Figure 7: ARC Fault Interface Module application diagram

**ENCLOSURE DIMENSIONS**

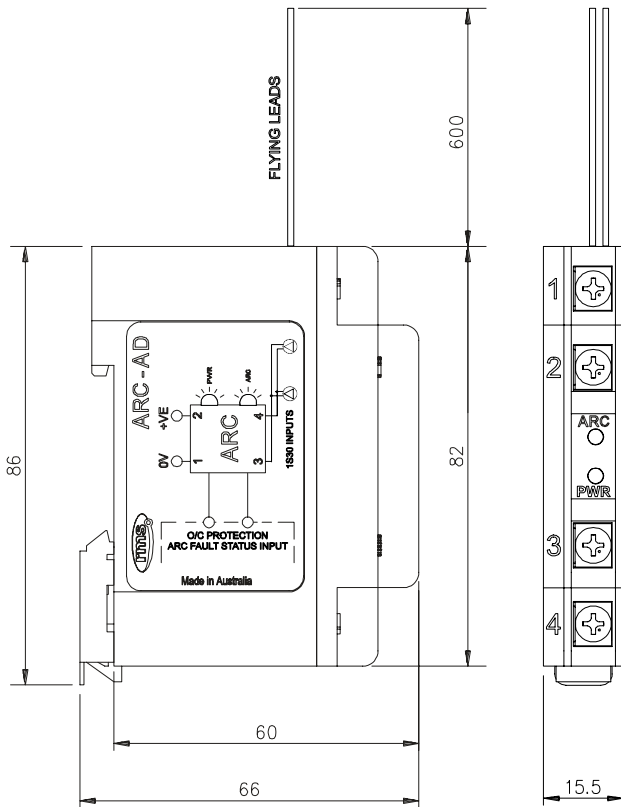


Figure 8: ARC Fault Interface Module dimensional details

**ARC SENSOR INPUTS**

One or two optical arc fault sensors type 1S30 may be connected to the ARC Module. Refer to the 1S30 Technical Bulletin for mounting options.

The number of sensors specified in the ARC ordering code must be connected to ensure correct operation of the sensor supervision function.

If only one sensor is connected to the ARC-B version the supervision output will indicate a sensor fail condition.

If two sensors are connected to the ARC-A version the supervision output will indicate a sensor fail condition.



Figure 9: 1S30 Arc Fault Sensor – front and back

**Mounting**

**DIN RAIL MOUNT ENCLOSURE**

The ARC Fault Interface Module is enclosed in compact enclosure sealed with thermally conductive potting compound. The module is designed for DIN rail mounting.

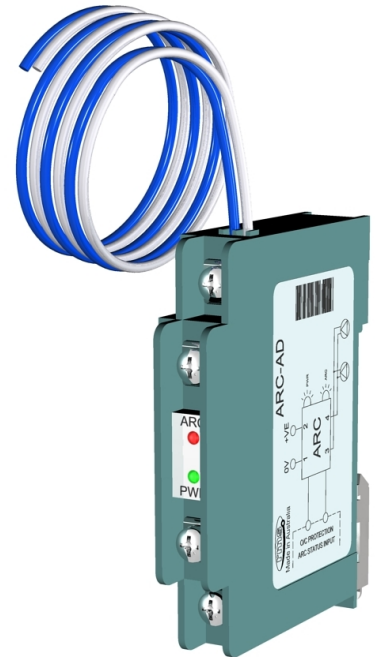


Figure 10: ARC Fault Interface Module depicting four (4) front screw terminals and two (2) top entry flying leads

**TERMINATIONS**

4x M4 screw terminals suitable for heavy duty ring lugs.

- Terminal 1: DC negative
- Terminal 2: DC positive
- Terminal 3: 1S30 arc fault in (Non polarized)
- Terminal 4: 1S30 arc fault in (Non polarized)

2x 600mm flying leads with 0.75 sq. mm conductor.

- Blue lead: Arc fault trip output - negative
- White lead: Supervision status output - negative

**MOUNTING**

DIN rail mounting of multiple DIN rail modules allows for a compact installation close to the protection relay status inputs. Wiring should be kept as short as practical to minimize the circuit resistance and possibility of noise on the protection relay status input.

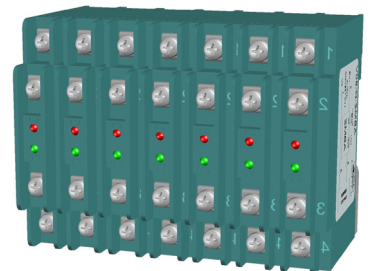


Figure 11: Array of 7x ARC modules

**OPTICAL SENSITIVITY**

~10,000 Lux\* for white light at normal incidence to the detector window(s) as depicted in figure 12:

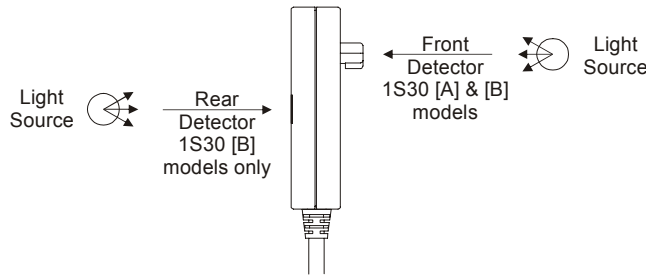


Figure 12:

As the illuminance of diffuse ambient sunlight falls in the range 5,000 to 10,000 Lux, this will not normally be sufficient to trigger the ARC Module. The luminous intensity from the sun at noon at the equator however is ~100,000 Lux which will be sufficient to trigger the ARC Module so measures should be made to avoid this situation.

**DETECTOR SPECTRAL RESPONSE**

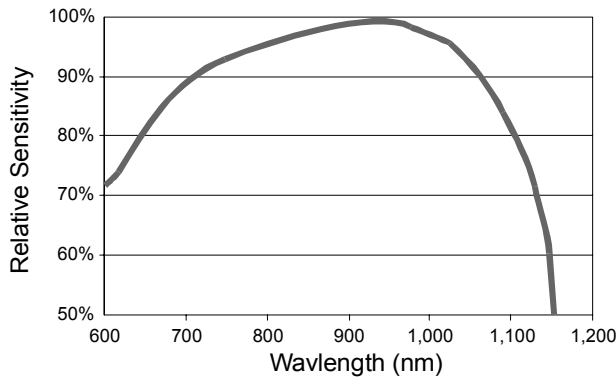


Figure 13:  
Arc detector spectral response

\* Due to the relatively high sensitivity of the detector to IR wavelengths the type of light source employed for sensitivity testing will have a major effect on the results obtained. Sensitivity testing should therefore be conducted using a 50-75W halogen lamp with an integrated aluminum reflector.

**SYSTEM SUPERVISION**

A CPU software watchdog monitors the system and in the event of an abnormal condition will automatically perform a soft restart.

Should this restart not clear the abnormal condition the system will revert to a safe mode with the outputs disabled. This will cause the self supervision healthy signal to be lost and the abnormal condition detected and reported by the protection relay via it's ARC supervision status input.

A front panel green LED is illuminated on the ARC Module under normal conditions. This LED is also switched off in safe mode.

**AUXILIARY SUPPLY BURDEN (At 110V DC)**

Monitoring mode: Less than 0.75W  
Arc fault detected: Less than 1.5W for 2s

**AUXILIARY SUPPLY**

The ARC Module is suitable for use with the following nominal auxiliary supplies. A tolerance of -20% to +20% must be maintained to ensure correct operation and to avoid thermal damage.

- Code A: 24V DC
- Code B: 32V DC
- Code C: 48V DC
- Code D: 110V DC
- Code E: 125V DC

**OPTICAL ARC FAULT DETECTION OPERATE TIME**

An arc fault trip signal is output in less than 1ms.

**MINIMUM ARC DURATION**

The minimum arc "flash" duration required to guarantee operation of the output contacts is 0.5ms.

**TRIP SIGNAL RESET TIME**

Once operated the trip output signal is self reset with a minimum dwell time of ~2s.

**OUTPUT CIRCUITS**

Dedicated non-isolated outputs are provided to connect to overcurrent protection relay status inputs as shown in figure 6. Upon detection of light intensity greater than the pick-up threshold a solid state switch connects the 0V rail to the relay status input.

**OUTPUT RATINGS**

**IEC60255-0-2**

The ARC Module outputs are designed for connection to dedicated protection class binary status inputs only. They are not suitable for direct tripping applications of auxiliary relays or circuit breaker coils.

The following ratings are conservative and are suitable for application with status inputs employed on many modern protection relays such as the Reyrolle RC and RM platforms

Supervision output

Open circuit voltage: 200V maximum  
Maximum current: 15mA for 5 ms  
4mA continuous

Arc trip output

Open circuit voltage: 200V maximum  
Maximum current: 15mA for 5 ms  
4mA for 95ms

**AUXILIARY SUPPLY**

**IEC60255-11**

Allowable breaks / dips in supply  
Collapse to zero from nominal voltage ≤ 20ms

**HIGH FREQUENCY DISTURBANCE**

**IEC60255-22-1 CLASS III**

2.5kV 1MHz common mode  
1.0kV 1MHz differential mode  
No mal operation

**ELECTROSTATIC DISCHARGE**

**IEC60255-22-2 CLASS III**

6kV contact discharge  
No mal operation

**RADIO FREQUENCY INTERFERENCE**

**IEC60255-22-3**

10V/m, 80 TO 1,000MHz  
No mal operation

**FAST TRANSIENT**

**IEC60255-22-4**

4kV, 5/50ns, 100KHz repetitive  
No mal operation

**TRANSIENT OVERVOLTAGE**

**IEC60255-5**

Between all terminals and earth  
The earth point is defined as the DIN rail mounting bracket.  
5kV 1.2/50us 0.5J  
2.0kV RMS for 1 minute

There is no isolation between any of the output terminals or flying leads. They should be considered as the same group.

**CONDUCTED RFI**

**IEC60255-22-6**

10V, 0.15 to 80MHz  
No mal operation

**TEMPERATURE RANGE**

**IEC68-2-1/2**

Operating: -5 to +55°C  
Storage: -25 to +75°C

**HUMIDITY**

**IEC68-2-78**

40°C and 93% RH non condensing

## Ordering Information

Generate the required ordering code as follows: e.g. ARC-BD

ARC - 

1	2

 ARC Module

**2 OPTICAL SENSOR INTERFACE**

- A Single 1S30 sensor input
- B Dual 1S30 sensor inputs

**2 AUXILIARY SUPPLY (Nominal)**

- A 24V DC
- B 32V DC
- C 48V DC
- D 110V DC
- E 125V DC

**1S30 ARC FAULT SENSOR**

Refer to the 1S30 Technical Bulletin for ordering information on the 1S30 arc fault sensor.

## **Australian Content**

Unless otherwise stated the product(s) quoted are manufactured by RMS at our production facility in Melbourne Australia. Approximately 60% of our sales volume is derived from equipment manufactured in house with a local content close to 80%. Imported components such as semi-conductors are sourced from local suppliers & preference is given for reasonable stock holding to support our build requirements.

## **Quality Assurance**

RMS holds NCSI (NATA Certification Services International), registration number 6869 for the certification of a quality assurance system to AS/NZS ISO9001-2008. Quality plans for all products involve 100% inspection and testing carried out before despatch. Further details on specific test plans, quality policy & procedures may be found in section A4 of the RMS product catalogue.

## **Product Packaging**

Protection relays are supplied in secure individual packing cardboard boxes with moulded styrene inserts suitable for recycling. Each product & packing box is labeled with the product part number, customer name & order details.

## **Design References**

The products & components produced by RMS are based on many years of field experience since Relays Pty Ltd was formed in 1955. A large population of equipment is in service throughout Australia, New Zealand, South Africa & South East Asia attesting to this fact. Specific product & customer reference sites may be provided on application.

## **Product Warranty**

All utility grade protection & auxiliary relay products, unless otherwise stated, are warranted for a period of 24 months from shipment for materials & labour on a return to factory basis. Repair of products damaged through poor application or circumstances outside the product ratings will be carried out at the customer's expense.

## **Standard Conditions of Sale**

Unless otherwise agreed RMS Standard Terms & Conditions (QF 907) shall apply to all sales. These are available on request or from our web site.



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